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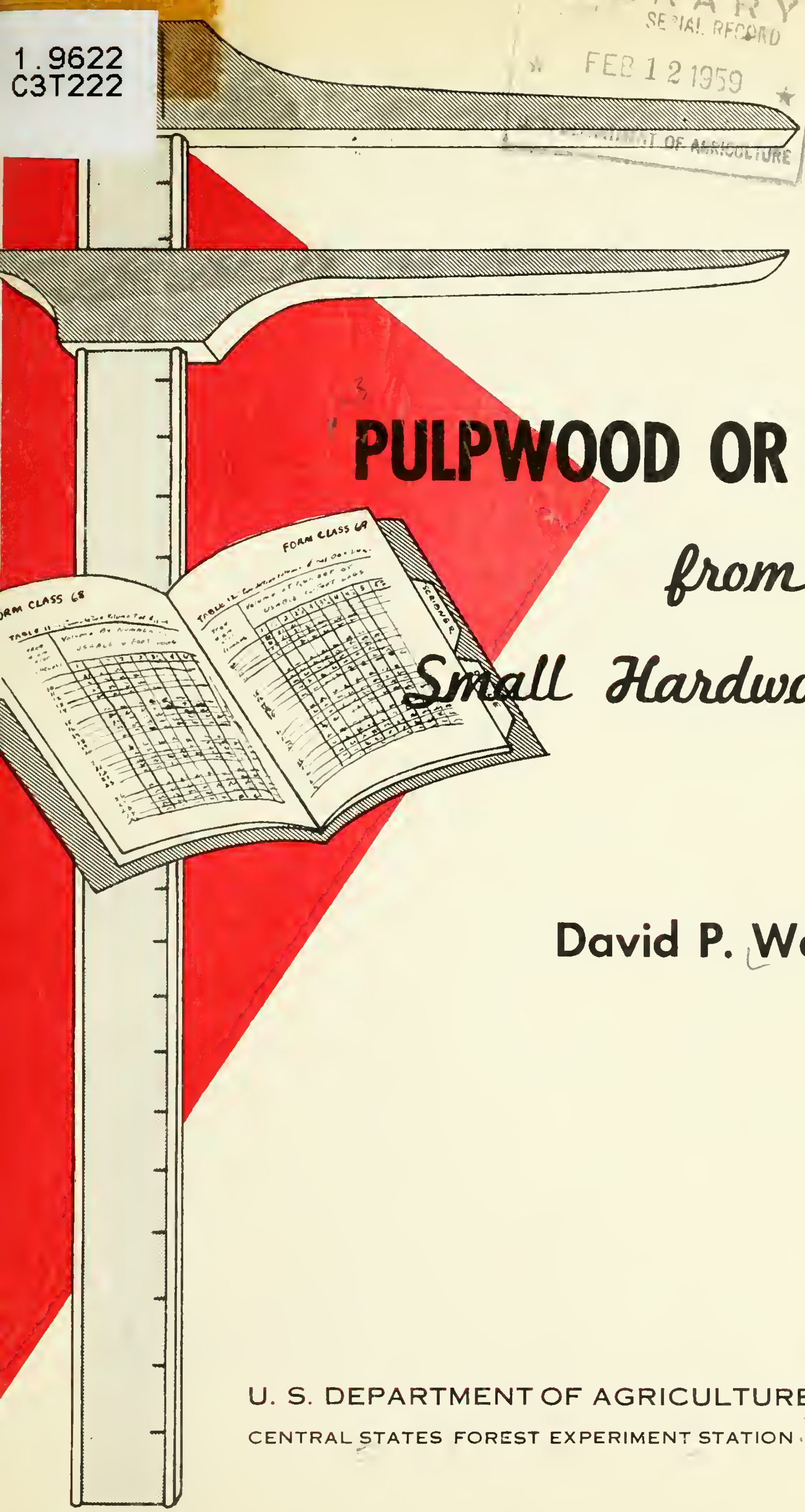

PULPWOOD OR SAWLOGS?
from
Small Hardwood Trees

David P. Worley

U. S. DEPARTMENT OF AGRICULTURE - FOREST SERVICE
CENTRAL STATES FOREST EXPERIMENT STATION - W. G. McGINNIES, DIRECTOR

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Small Hardwood Trees

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Unlike most raw agricultural products, standing timber can be converted into a number of products, each with its own peculiar unit of measure. This variety of commercial measurements presents difficulties in comparing the volume and value of standing timber for different forest products. Converting from pulpwood measures to sawtimber measures is particularly confusing. Pulpwood is usually sold by the cord, 4 feet or longer, either rough (including bark) or peeled (without bark). On the other hand sawtimber is sold by the thousand board-feet according to one of a number of rules. Both these products can come from pole-sized and small sawtimber-sized trees ranging from 8 inches to 14 inches in diameter while larger trees are usually cut into sawlogs or processed for higher value products as veneer.

Many empirical studies have been made in different parts of the country to develop local factors for converting from one unit of measure to another. These studies have produced widely different converting factors depending upon local timber conditions and forest product specifications. Such studies, if they are well designed, form the only sound basis for comparisons in any restricted locality, but they are often misleading when applied to another area or when applied regionwide.

There is a need then for a set of general converting factors equating common commercial forest products units for reconnaisance investigations where local studies have not been made and as an aid in conducting marketing and economic appraisals over a broad area. Such a set of factors were developed for pine timber several years ago (3).[1] This paper presents comparable factors for converting hardwood timber volume from cords to board-feet and vice versa. These factors were derived by equating forest product units to the volume of a standard cord of rough round wood assuming normal taper and merchantable lengths of central hardwood timber.

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[1] Numbers in parenthesis refer to Literature Cited, page 7.

What is a Standard Cord?

The standard cord of rough (unpeeled) wood is used as the common denominator because it is a unit of volume nearly everyone is acquainted with. Ideally it is composed of 4-foot sticks stacked in a pile 4 feet high and 8 feet long containing 128 cubic feet of space. The solid content in a cord varies from 52 cubic feet to 98 cubic feet of solid material because of differences in bark thickness, straightness, and size of sticks (6). Many authorities though (1, 2, 5) accept 90 cubic feet as a reasonable solid content of a cord composed of straight sticks which might be used either for sawlogs or pulpwood. The 90-cubic-foot cord is used here.

Number of Trees in a Standard Cord

First, the number of trees of different heights and diameters required to make a standard cord was estimated. Several merchantable heights within the normal range for each tree diameter class were used because merchantable height in hardwood trees varies depending on limbiness, forking, and taper. Then cord volumes for trees of form class 75 and 80 were determined because small hardwood timber usually has a taper within this form-class range (1, 2, 4, 5). The frustum of a cone was used as the shape of the tree bole. The breast high diameter inside bark for medium-barked trees was computed to be 90 percent of diameter outside bark. This figure was used for all trees because the range between thick and thin barked trees was so narrow: 87 percent for thick barked trees and 93 percent for thin. (For a complete discussion of techniques for computing bark volume, see reference 5.)

The inside and outside bark diameters at both ends of each 8-foot section of the merchantable stem were caluclated for trees in the two form classes. Minimum outside bark diameter depends upon tree taper and the arbitrary merchantable heights chosen. The smallest o.b. diameter of the top sections of those trees with the longest merchantable length averaged about 6 inches for each diameter class. The outside-bark cubic-foot content of each section was obtained by applying Smalian's formula. The volumes of successive sections were added to obtain the total cubic foot volume of trees of different heights and diameters. The number of trees required to make 90 cubic feet or a cord was then computed (table 1).

Table 1.--Number of trees to make a cord by d.b.h. and merchantable height

D.b.h.	Merchantable height (feet)					
	8	16	24	32	40	48
FORM CLASS 75						
8	33.0	18.2	13.5			
10		11.6	8.8	7.3		
12		8.1	6.0	5.0	4.5	
14		6.0	4.6	3.8	3.3	3.1
FORM CLASS 80						
8	32.0	17.3	12.5			
10		11.0	8.1	6.4		
12		7.8	5.7	4.6	3.9	
14		5.6	4.0	3.2	2.7	2.5

Number of Cords in a Thousand Board-Feet

Board-foot volumes according to the International 1/4-inch, Scribner, and Doyle rules were computed from the inside-bark, small-end diameters of the 8-foot sections. Again no minimum inside-bark diameter was used for estimating board-foot volume. The tallest trees in each diameter class though produced top logs whose small end d.i.b. was between 5 and 6 inches. The volumes thus determined were summed for trees of different diameters and heights and multiplied by the appropriate number of trees per cord previously determined. The number of cords per thousand board-feet for each diameter and merchantable height was computed (table 2). These values were adjusted graphically to eliminate inconsistencies encountered due to the arbitrary tree-height selection for each d.b.h.

Two cord values are given for each tree diameter: The lower cord value in each case applies to trees with 8- or 16-foot merchantable length as shown in table 1, and the larger cord value to trees with the longer merchantable lengths. This is because the smaller logs in the upper portion of the tree yield fewer board-feet per cubic foot than the larger logs in the lower or butt section of the tree. Both values are given because the upper portions of the tree

Table 2.--Number of cords per thousand board-feet of standing timber

FORM CLASS 75

D.b.h.	Int. 1/4" Short trees	Int. 1/4" Tall trees	Scribner Short trees	Scribner Tall trees	Doyle Short trees	Doyle Tall trees
8	2.6	2.8	3.4	4.1	7.6	10.5
10	2.4	2.6	3.1	3.7	6.1	8.4
12	2.3	2.4	2.9	3.3	5.0	6.7
14	2.2	2.3	2.7	3.0	4.1	5.2
FORM CLASS 80						
8	2.4	2.6	3.1	3.5	7.0	9.4
10	2.3	2.5	2.8	3.2	5.6	7.2
12	2.2	2.3	2.6	2.8	4.5	5.5
14	2.1	2.2	2.3	2.5	3.4	4.1

may not offer alternative market possibilities while the lower portions or butt log may be suitable for either pulpwood or sawlogs. Also, trees with intermediate merchantable lengths may be dealt with by using a value between the two extremes. This provides the opportunity to select an appropriate converting factor for different conditions of tree diameter and merchantable length.

Comparative Stumpage Values for Hardwood Trees

These converting factors facilitate comparing stumpage values for different sized trees. For example, assume pulpwood stumpage at $2.00 per unpeeled standard cord and sawtimber at $15.00 per thousand board-feet Doyle rule. The following value comparison for trees of the longer merchantable lengths of form class 75 can be quickly calculated.

D.b.h. Inches	Sawtimber Value Doyle Rule	Equivalent Pulpwood Value at $2.00 Per Cord
8	$ 15.00	10.5 x $2.00 = $ 21.00
10	15.00	8.4 x 2.00 = 16.80
12	15.00	6.7 x 2.00 = 13.40
14	15.00	5.2 x 2.00 = 10.40

If timber is sold by the International 1/4-inch rule at the same rate the value comparison would be as follows:

D.b.h. Inches	Equivalent Pulpwood Value at $2.00 Per Cord
8	$ 5.60
10	5.20
12	4.80
14	4.60

Value comparisons are by no means restricted to cords vs. board-feet. For example, assume that it is desired to compare sawtimber values for timber of form class 80 when it sells at $15.00 per thousand board-feet International 1/4-inch rule or at $25.00 per thousand board-feet Doyle rule. Using, again, a converting factor for longer merchantable lengths from table 2 the following value comparison is calculated.

	Sawtimber	
D.b.h.	International 1/4-inch rule (Equivalent Value Per Thousand Board-Feet Doyle Rule)	Doyle rule
8	9.4/2.6 x $15.00 = $ 54.22	$ 25.00
10	7.2/2.5 x 15.00 = 43.20	25.00
12	5.5/2.3 x 15.00 = 35.85	25.00
14	4.1/2.2 x 15.00 = 27.90	25.00

Even at the lower stumpage rate the value of the timber is greater when using International 1/4-inch rule up to about 14 inches d.b.h.

The price of sawtimber measured by any of these rules can be equated to the price of pulpwood measured in standard cords or any other sawtimber measure shown in the table. This then forms the basis for objective value comparisons for regional surveys as well as aiding the stumpage seller, buyer, or appraiser to evaluate competitive prices for these units.

Peeled Cords or Rough and Peeled Units

Many purchasers specify that stacked cordwood be peeled, and many companies require lengths other than the standard 4 feet. Probably the next most common length is 5 feet; cords of 5-foot wood are often called long cords or units. A 5-foot cord contains approximately 1.25 standard cords. This is true whether the conversion is made for rough wood or for peeled wood and does not vary with height and diameter.

Peeled wood, whether it is measured in a standard or long cord, does not bear such a constant relationship to unpeeled wood. Different bark thicknesses result in different volumes of bark in an unpeeled cord. This bark portion of the solid content of an unpeeled cord must be filled with solid wood in the peeled cord. The simple computation of bark volume to be supplanted by wood volume though is not an altogether satisfactory solution to the problem because the ridges and fissures in unpeeled wood tend to mesh together creating a net solid material difference somewhat less than the bark volume itself. Bark volume per cord was computed for each of the different bark thicknesses used earlier and was multiplied by 0.8 (5) to reduce it to net bark volume in a stacked cord. From this then was calculated the number of unpeeled cords required to make a peeled cord and a peeled unit (table 3).

Table 3.--Number of standard cords of unpeeled wood to make one standard cord or one long cord of peeled wood

Peeled wood	Standard cords unpeeled wood: Thin bark trees[1]	Standard cords unpeeled wood: Medium bark trees[2]	Standard cords unpeeled wood: Thick bark trees[3]
One standard cord	1.12	1.17	1.23
One long cord	1.40	1.47	1.55

[1] Such as red maple, beech.
[2] Such as red oak, scarlet oak, white oak.
[3] Such as black oak, chestnut oak.

Table 3 can be used to compare stumpage prices between wood measured by the peeled cord and wood measured by the rough cord. For example: Is the value of scarlet oak stumpage greater if sold on a rough wood measurement of $1.50 per long cord or on the basis of peeled volume at $1.75 per long cord? Since the value of stumpage sold on rough wood measurement is $1.50 it compares favorably with the equivalent value of 1.25/1.47 x $1.75 = $1.49 per long cord of stumpage sold on basis of a peeled wood measurement.

If rough pulpwood from medium barked species brings $15.00 per long cord delivered at the siding, will the operator have a reasonable margin for peeling the wood if peeled wood brings $20.00

per long cord? Assuming equivalent stumpage values the rough wood value equivalent of peeled wood is 1.25/1.47 x $20.00 = $17.00 per long cord. He has a margin of $2.00 then for peeling a long cord of rough wood.

Value comparisons between units of measurement shown in table 2 can be made with units from table 3 using the methods just described.

A Word of Caution

It must be pointed out that the information in these tables is suited only to exploratory investigations in particular localities or for making conversions on a regional basis where use of empirical data may lead to biased results. Local timber conditions and product specifications may impose systematic errors as high as 15 percent on conversions made locally with this table. In any particular forest area it is always best to determine these relationships from data gathered on the ground.

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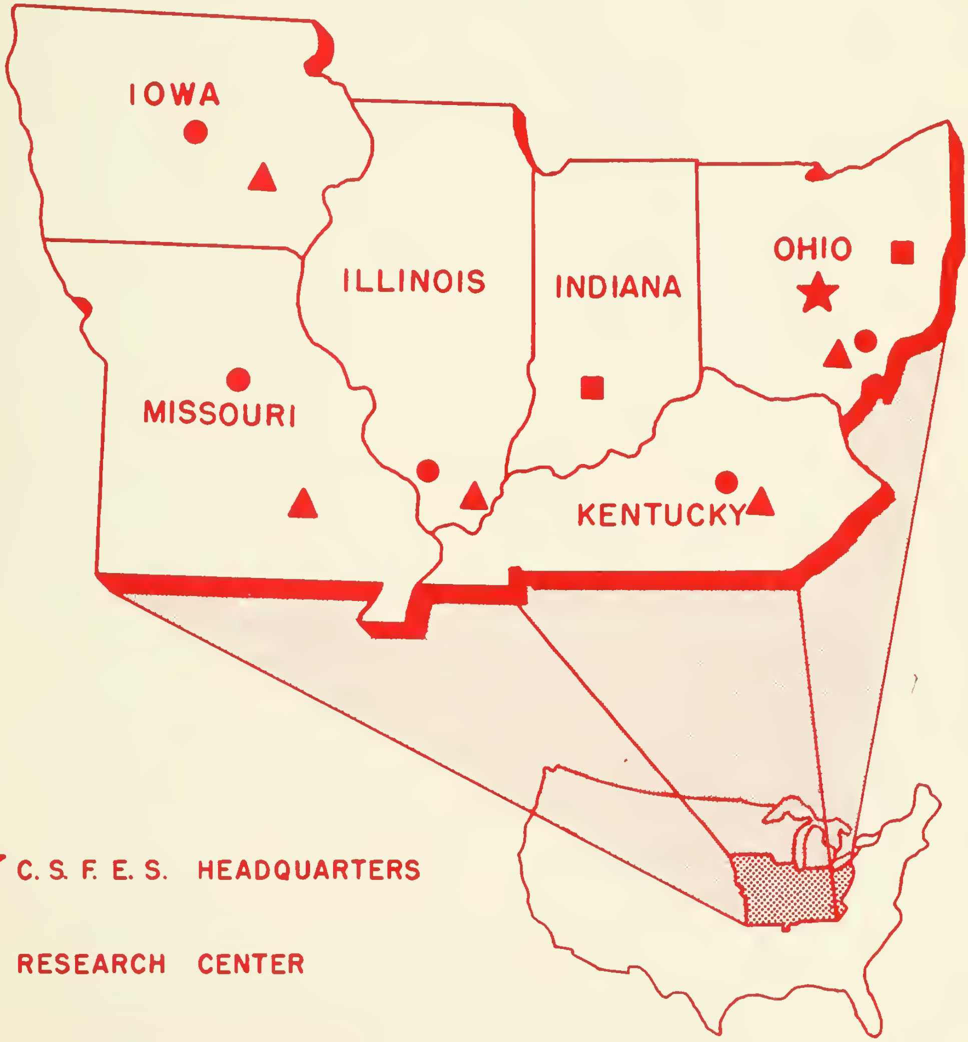

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